The National Estuarine Research Reserve System

(NERRS)

The State of Estuarine Education: K–12 Needs Assessment

Full Report

Conducted by TERC

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Introduction, Goals and Methods

The National Estuarine Research Reserve System (NERRS) is dedicated to conservation, research, education, and stewardship activities in America's estuaries—coastal areas where rivers meet the sea. In 2006, as part of its long-term initiative working towards creation of a national K–12 estuarine education program, the NERRS contracted with TERC, a non-profit educational research and development organization in Cambridge, MA, with expertise in math, science, and technology, to develop high school level estuaries-related curriculum materials and professional development supports, and to conduct a K–12 needs assessment of the state of estuarine education in the nation's schools. This needs assessment serves dual purposes:

1) It directly informs the development of the curriculum and professional development materials; and
2) It provides NERRS with data about the current state of K–12 teaching about estuaries in the nation's schools, which can inform ongoing development efforts and serve as a reference point for measures of impact of NERRS initiatives.

Research questions

The NERRS Needs Assessment Survey was designed to answer the following questions:

1) How can we characterize teachers who might teach about estuaries, the contexts in which they teach, and the general teaching methods they use? *What are their backgrounds, experiences, and current situations? What teaching methods and kinds of curriculum materials do they prefer to use?*
2) How do estuaries, or topics related to estuaries, and teaching methods particularly suited to teaching about estuaries, fit with what teachers currently teach? *How much time do they currently spend teaching about estuaries? How much knowledge do they have about a range of estuarine-related topics and how likely are they to teach these? What role do field experiences currently play in their teaching? Where do they currently get information and materials related to estuaries?*
3) How can new estuarine-related curriculum materials and professional development be designed to increase the likelihood that they'll be used? *What are teachers goals in selecting supplementary curriculum materials? What supports and obstacles do teachers perceive they have in adopting new curriculum materials? What are teachers' preferences for delivery of materials? What are their needs for professional development training and their preferences for its delivery?*

A key challenge faced by NERRS in its educational initiatives, and TERC in the design of this needs assessment, is the relative lack of *direct* attention to estuaries in the nation's schools. The word "estuaries" does not appear *per se* in many state standards, although the underlying science concepts embodied in estuaries have broad connections throughout the standards. For example, most state science education standards refer to understanding "Earth as a system," with interwoven cycles and processes relating to land, air, and water. Estuaries provide engaging and accessible examples of these processes at work. Estuaries also integrate key concepts in biology (e.g. habitat adaptations), chemistry (e.g. salinity analysis) and physics (e.g. wave motions). Furthermore, most state standards call for inquiry-based learning through hands-on experiments, direct observations, and active use of data—all of which occur as students engage with estuaries. Thus, the needs assessment was designed to tap these indirect references to estuarine concepts as well as direct teaching about estuaries.

Research methods & choices

The NERRS Needs Assessment Survey was developed by TERC in collaboration with NERRS educators and a focus group of classroom teachers during the fall of 2006 and early winter of 2007. Through this process, we developed and reviewed draft questions and solicited feedback on survey language, questions, response options, length, and other features. A NOAA Technical Advisory Committee also provided feedback. (See Appendix for a copy of the Needs Assessment.)

The TERC Principal Investigators applied for and received approval from TERC's Institutional Review Board (IRB) for the research methods and informed consent documents we used in this needs assessment research (IRB approval letter dated 13 December 2006). TERC's IRB is compliant with the Office for Human Research Protections (OHRP) guidelines under federal-wide assurance number FWA00010418. In particular, participation in the research was entirely voluntary and information which could identify individual participants' responses was not collected, in order to protect their privacy. A consent form describing the research and the approximate time burden (estimated and confirmed to be 20 to 40 minutes on average—see Appendix for details) was affirmatively completed by all respondents prior to participating in the survey itself. Respondents' actions confirm that they understood the survey was voluntary—3% of those who logged on did not consent (and so were thanked and did not complete the survey), and 24% of the remainder chose to end their participation early.

Geographic scope. NERRS Reserve Sites offer educational programs at 27 locations across the US, covering 23 states and Puerto Rico. Because of the NERRS's interest in estuarine education across the country, the needs assessment and recruitment were designed to gather information from teachers nationally, including those living far from the coasts and estuaries typically served by NERRS. Because there is a NERRS located in Puerto Rico (Jobos Bay NERR) and some of the Reserves serve Spanish-speaking communities, we developed the survey in Spanish as well as English (thank you to the NERRS staff who translated the survey into Spanish).

The survey was launched online in both English and Spanish using the online survey collection software, *SurveyMonkey* (http://surveymonkey.com/). Although conducting the survey online limited responses to those with ready access to and comfort with computers and the Internet, the ability to announce and distribute the survey broadly at little cost seemed worth the tradeoff. The survey was promoted by a wide variety of environmental and educational organizations, some of whom offered educationally related incentive prizes to be raffled off to interested participants. **Table 1** lists the

organizations who agreed to publicize the survey and/ or provide incentive prizes. Each organization or listserve reaches between hundreds to several thousand people. We want to take this opportunity to thank all the individuals and organizations who supported our work by publicizing and promoting the needs assessment survey.

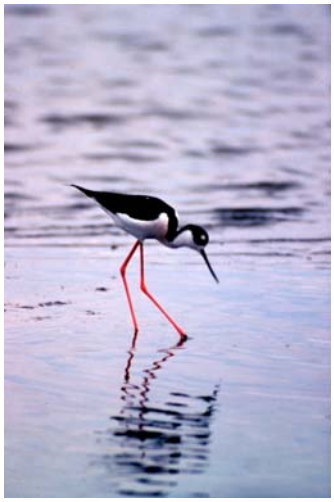
Organization	Method to publicize survey	Incentive prize(s)
National Estuarine Research Reserve System (NERRS)	Several Listserves	40 Estuaries Prize packages
National Oceanic and Atmospheric Administration (NOAA)	Education Council Listserves	20 NOAA Prize packages
National Association of Biology Teachers (NABT)	Weekly electronic newsletter	1 Annual Membership
North American Association for Environmental Education (NAAEE)	Biweekly electronic newsletter	1 Annual Membership
National Earth Science Teachers Association (NESTA)	Listserve & Web-based newsletter	1 Annual Membership
American Geological Institute (AGI)	Online GeoSpectrum magazine	50 Earth Science Week Kits
American Chemical Society (ACS)	Electronic Newsletter	Molar beach ball Caffeine formula mug
American Association of Physics Teachers (AAPT)	Listserve, Electronic Newlsetter	3 prize kits (T-shirt, book & mug)
US Department of Education (DOE)	Biweekly ED Review Newsletter	
US EPA Teaching Center	Listserves	
US Forest Service Education Center	Listserves	
National Science Teachers Association (NSTA)	Website calendar & Listserves	
National Marine Educators Association (NMEA)	Bulletin Board Announcements	
North American Association of Environmental Educators (NAAEE)	Newsletter	
Council for Environmental Education	Listserve	
Council for State Science Supervisors	Listserve	
American Indian Science and Engineering Society (AISES)	Listserve	
Society for Advancement of Chicanos and Native Americans in Science (SACNAS)	Website Announcement	
ChemCom Listserve	Listserve	
Middle School Science Listserve	Listserve	
Teaching Science Listserve	Listserve	
Educational uses of GIS (EdGIS) Listserve	Listserve	
TERC	Various Distribution Lists	

Table 1: Organizations publicizing and promoting the TERC/ NERRS Needs Assessment Survey

During the 10 weeks that the survey was available for responses, 1342 people logged onto the survey. After the survey was closed, the 118 incentive prizes were raffled off among the 414 people who voluntarily (and separately from the survey itself) sent us their contact information, first randomly picking 118 winners, then randomly assigning them to the 118 prizes. Winners were sent their prizes by the sponsoring organizations; non-winners were informed of their status and thanked by email. The data were exported, cleaned, and analyzed using Microsoft Excel (Microsoft, 2004, v.11.3.5), the

Statistical Package for the Social Sciences (SPSS: SPSS, 2005, v.11.0.4 for Mac OSX), and Fathom (KCP Technologies, 2007, v.2.1).

Results



How can we characterize teachers who might teach about estuaries, the contexts in which they teach, and the general methods they use?

In this section, we'll address the research question above by exploring the following sub-questions: What are teachers' backgrounds, experiences, and current situations? What teaching methods and kinds of curriculum materials do they prefer to use?

The NERRS Needs Assessment Survey was not designed to collect a representative random sample of teachers and environmental educators across the US. However, the fairly large group of educators who responded are roughly similar to the larger population of US teachers in a variety of ways which we will describe below. This rough similarity suggests that the information collected may be applicable to the larger population of educators, although those who heard about and chose to respond to the survey may be different from that larger population in systematic ways which might bias their responses—for example, at minimum, they have access to computers, and likely have a higher than average interest in the topic. The demographic information collected in the survey can also be used to distinguish responses by subgroups in the sample—describing differences in patterns of responses for teachers of different levels of students; or those in schools compared to those in other settings; or those living in coastal areas to those living further away; or those who teach different subject areas.

Although a grand total of 1342 people logged onto the survey, only 988 (974 in English and 14 in Spanish) of these completed consent forms and continued past the first several pages of background information into the more content-related pages (see Appendix for further details). **These 988 represent the working sample of the survey reported here.**

Teaching settings

Of the 988 respondents, **837 (85%) said they worked in some kind of school setting,** including public schools, public charter schools, parochial schools, other private schools, and virtual schools. 176 respondents (18%) said they worked in some kind of informal

education setting including Environmental education, Outdoor education, and other informal education settings. 50 respondents (5%) said they taught in after school programs—some of these also taught in school or informal education settings. Finally, 57 respondents (6%) said they taught in other educational settings—e.g., universities/ colleges, state agencies, and community organizations. **Error! Reference source not found.** and **Figure 1** show the relative proportion of respondents from each setting—subgroup numbers don't exactly add up since some people taught in more than one setting.

All Respondents										
988 (100%)										
All Schools					After School	Informal Education			Other Setting
837 (85%)						176 (18%)			
Elementary		Middle School		High School					
231 (23%)		369 (37%)		363 (37%)					
Public School	Charter School	Parochial School	Other Private School	Virtual School		Outdoor Education	Environmental Education	Other Informal Education	
760 (77%)	26 (3%)	49 (5%)	44 (4%)	8 (1%)	50 (5%)	52 (5%)	88 (9%)	88 (9%)	57 (6%)

Note: *Subgroup totals are more than 100% because some respondents taught in more than one setting.*

Table 2: Teaching Settings of Respondents

For some of our comparative analyses, we needed to assign respondents to a "primary setting" with no overlaps. We did so—Schools first, followed by Informal settings for those who didn't teach in schools, followed by After schools for those who didn't work in either schools or informal settings, followed by Other. This analysis left 837 (85%) respondents in schools, as before, but only 121 (12%) informal educators who don't also work in schools, just 2 after school educators who don't work in schools or informal settings, and 27 (3%) others. Based on the small number of people with After schools as their primary setting, we decided not to include "After school" in further analyses.

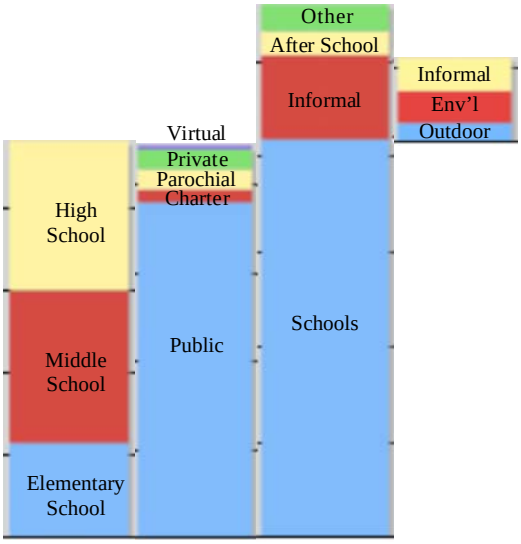


Figure 1: Graphic View of Educational Settings of Respondents

While informal educators seem to teach across the grade span, those teaching in schools typically focus on a specific grade range. We defined grades K–5 as "Elementary", grades 6–8 as "Middle", and grades 9–12 as "High School"—although some schools are divided differently, and our data still show some overlap. **Of the 837 teachers in school settings, 231 (28%) teach in elementary schools, 369 (44%) teach in middle schools, and 363 (43%) teach in high schools.** When we assigned school teachers to a "highest level" category—High school, Middle school for those who don't also teach high school, or Elementary school for those who don't also teach at middle or high school—we found 363 high school teachers, 303 middle school teachers, and 153 Elementary teachers. We will occasionally use this "Highest level" category to look for differences among school teachers.

Subject areas taught

Knowing which subject areas are taught could help us design curriculum materials to better fit teachers' needs. **We found differences by teaching context and grade level in the subject areas taught.** For example, while 86% of Informal educators say they teach Environmental science, only 44–50% of school teachers say so. While 56% of Middle school teachers, and 70% of Elementary school teachers, as well as large percentages of informal educators say they teach General science, only 19% of High school teachers say so. **Figure 2** shows the percentages of teachers in each group teaching each subject area domain. Subject areas are ordered left to right according to the prevalence of high school teachers teaching each subject, since these teachers are more likely to specialize.

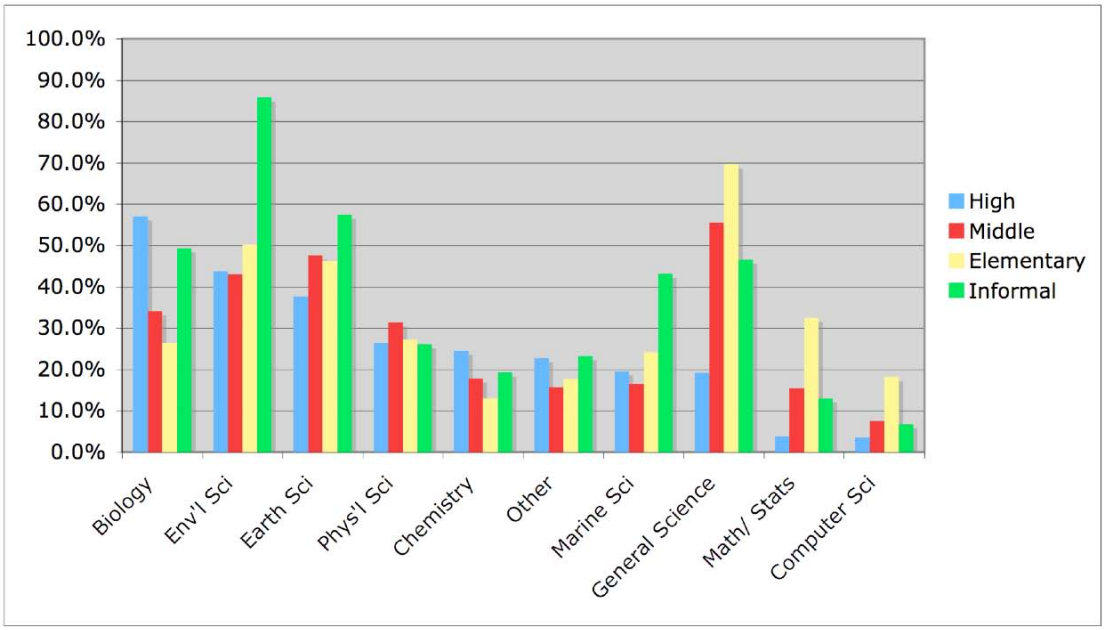


Figure 2: Subjects taught

Large numbers of high school teachers in our sample teach Biology (57%), Environmental science (44%) or Earth science (38%), with Physical sciences, Chemistry, Marine science, General science and Other accounting for between 20% and 25% each. Informal educators are more likely than school teachers to teach Environmental science, Earth Science, and Marine science, and more likely than middle and elementary teachers to teach Biology—these differences are statistically significant.

High school teachers in our sample are more likely than other school teachers to teach Biology and Chemistry, and less likely to teach General science, Earth science, Computer science, or Math/ statistics, and these differences are statistically significant (see Appendix for statistical details).

Geographic distribution

We wanted to know where teachers were located to determine if we had gotten a reasonable geographic distribution of responses. Educators told us the state they work in and their zip code. **Respondents hailed from all but three of the 50 states** (Vermont, Idaho, Montana) as well as from Puerto Rico, the District of Columbia, and a few from non-US sites (New Zealand, Guam, Ontario, Mexico). **Number of responses per state ranged from none to a high of 106** (North Carolina). Because the states differ in population, we calculated the number of responses on the survey per million residents. Five states (Louisiana, North Carolina, Virginia, Maine and Wyoming) have more than 10 responses per million residents. Thirty states have at least 2 responses per million residents, though several large population states that fall under this proportion still have substantial numbers of responses (Massachusetts, 11 responses, 1.8/ M; California, 54 responses, 1.8/ M; Wisconsin, 8 responses, 1.6/M; Texas, 27 responses, 1.6/M; Pennsylvania, 16 responses, 1.3/M). The states that may be underrepresented in the sample—those which have both less than 2 responses per million inhabitants, and 5 or fewer responses overall include: Idaho, Montana, Vermont, Tennessee, Utah, Colorado, Iowa, Indiana, Missouri, Arizona, Hawaii, West Virginia, Connecticut, Nebraska, Delaware, and Oklahoma. **Of the underrepresented states, Connecticut and Delaware may be a concern as these have important estuaries.**

We also asked respondents to report their zip codes and then used a database from NOAA's Coastal Services Center which identified zip codes that were within National Ocean Economic Program (NOEP)-defined coastal counties to determine which respondents were "coastal". By this measure, **467 of the 988 respondents (47% overall) identified themselves as living in coastal zip codes** (46% of those teaching in schools; 49% of those in informal settings; 42% of those in after schools; 50% of those in other settings). Using the same data set, we find that in 2005, 43% of the overall US population lived near the coast. Statistical tests show that **the needs assessment response sample is somewhat more likely to be from coastal areas than the US population as a whole**, although these differences are only statistically significant for teachers in schools (see Appendix for statistical details).

Respondents described the type of community (urban, suburban, rural, other) their students come from (we asked this rather than the community they taught in to allow informal educators to list several types—which is also why the numbers total to more than 100%). **Responses were roughly the same across all teaching contexts: Urban 32%, Suburban 55%, Rural 48%, Other 2%**. Both the rural and urban percentages in our sample are somewhat high for the country as a whole, and the suburban percentage is slightly low (see **Table 3**).

Demographic characteristics of students

Respondents reported the racial/ ethnic background of their students. On average, we calculate our sample as about 60% white, 20% Black, and 15% Latino/a (see Appendix for calculation details). This is roughly comparable to the overall US average of 58% white, slightly higher than the US average of 16% Black, and slightly lower than the US

average of 20% Hispanic. Most educational settings in this sample are majority White—only 31% said that Whites constituted half or fewer of the student population, with a full 42% saying Whites were more than 75% of the student population. Just over half of settings (53%) had fewer than 10% Black students, with 13% having majority Black populations (15% of Schools). Latinos represented an even smaller fraction of the average student population, with 48% of schools having fewer than 5% Latino students and another 38% having between 10 and 25% Latinos. In 91% of schools (83% of non school settings), Asian students number fewer than 10% of the population. Native Americans represent less than 5% of students in nearly all (97%) of schools (86% of non school settings). Except where noted, these statistics are essentially the same across all the educational contexts.

Category	Sample	US Population	Comments
Coastal	47%	43%	Difference significant for school teachers
Urban	32%	21%	Differences significant for all community categories
Suburban	55%	58%	
Rural	48%	21%	
Other	2%		
White	60%	58%	Statistical tests of these differences (and FRL/ ELL) were not conducted because the method of reporting and calculation didn't allow it
Black	20%	16%	
Latino/ Hispanic	15%	20%	
FRL	39%	41%	
ELL	19%	6%	Half of the English language learners (ELL) in our sample were in contexts with almost exclusively ELL students

Table 3: Sample Demographic Statistics

We were interested in economic and linguistic characteristics of the students taught. We used eligibility for free or reduced price lunch (FRL) as a proxy for limited economic resources, and the percentage of students classified as English Language Learners (ELL) as an indicator of linguistic diversity. Not all educators reported this information—15%–17% didn't respond to this question overall, though this was only 8–10% of those in schools. **On average, 39% of students are eligible for free or reduced price lunch, compared with 41% in the nation as a whole** (see **Table 3**). Of those responding, about half (44%) of educators report 25% or fewer of their students are eligible for FRL; with roughly equal numbers (17–20%) in each of the other quartiles (25–50%, 50–75%, and >75%). Linguistic diversity in schools is more rare—about half the contexts (49%) have fewer than 5% ELL students, with 80% having no more than 25% ELL students. **Still, this averages out to about 19% of students in our sample who are English Language Learners (though half of these are in contexts that are almost exclusively ELL), as compared to an overall US average of just 6%** (see Appendix for calculation details).

Teacher characteristics

Overall, needs assessment survey respondents are 78% female. Sixty percent (60%) of respondents have an academic degree in science (58% of those in schools, 67% in other settings, which is a statistically significant difference, see Appendix for details). In schools, teachers' credentials include 37% with Bachelors degrees, 59% with Masters degrees (slightly fewer, 45% of those in non-school settings) and 3% with Doctoral

degrees (slightly more, 11% in non-school settings, though these differences are not statistically significant). Overall, 86% of respondents are certified to teach, though this is 94% of those in schools and only 43% of those in non-school settings (a statistically significant difference). In both school and non-school settings, respondents have taught for an average (mean) of nearly 14 years, and have been teaching science for 12 years. One-fourth of teachers in all contexts have taught 6 years or less, the median is 12 years, and another quarter have taught 20 years or more.

Among teachers in school settings, there are some differences in teacher characteristics by school level taught. For example, while women make up 89% of elementary teacher respondents, and 83% of middle school teachers, only 70% of high school teacher respondents are female. Even more striking, while 83% of high school teachers responding have science degrees, only 51% of middle school teachers and just 30% of elementary teachers have these degrees. Finally, high school teachers have been teaching science for an average of about 2.5 years longer than elementary or middle school teachers (all these differences are statistically significant, see Appendix.) These differences may affect the professional development support that teachers at different levels need.

	Overall	Non-School	All Schools	Elementary	Middle	High
Female	78%	76%	79%	89%	83%	70%
Bachelors	37%	39%	37%	43%	44%	30%
Masters	57%	45%	59%	52%	53%	66%
Doctorate	4%	11%	3%	2%	1%	3%
Science Degree	60%	67%	58%	30%	51%	83%
Certified Teacher	86%	43%	94%	85%	91%	92%
Yrs Teaching	13.89	14.06	13.86	13.10	13.78	14.27
Yrs Tchg Science	12.03	12.69	11.92	11.08	11.10	13.47

Table 4: Teacher characteristics

General resource availability

Curriculum materials need to be designed keeping in mind the time frames and resources teachers have available. We asked teachers how many students they teach and how long their classes are. There were a wide range of answers, in part because informal educators often teach large groups, and some people reported the total number of students they reach while others described the typical size of individual groups. Median and distributional values—especially the interquartile range (IQR) or middle half, whose lower bound is the 25th percentile and upper bound is the 75th percentile—are, thus, better measures of typicality for these data. **The median class size among all respondents was reported as 25** with the IQR ranging from 21 to 35 students. For class length, the IQR ranged from 45 to 90 minutes, **with a median of 52.5 minute classes**. Only 23% of respondents said they had longer lab classes, though this is 50% of non-school respondents, 31% of elementary school respondents and about 15% of middle and high school respondents. **Class sizes and lengths differ by school level taught**—see **Table 5** below for details. **Finally, while non-school educators take**

classes outdoors frequently, this is a rare occurrence for those teaching in schools (see Appendix for statistical details).

	Overall	Non-School	All Schools	Elementary	Middle	High
Class size 25%[a]	21	20	22	20	23	22
Class size 50%	25	25	26	25	27	28
Class size 75%	35	35	35	30	34	40
Class minutes 25%	45	50	45	45	45	50
Class minutes 50%	53	80	50	46	50	60
Class minutes 75%	90	150	84	60	60	90
Lab class?	23%	50%	18%	31%	13%	15%
Lab minutes 25%	51	60	50	53	45	60
Lab minutes 50%	85	150	75	60	69	90
Lab minutes 75%	120	240	90	101	90	94
Outdoors 25%	yearly [b]	monthly	yearly	yearly	yearly	yearly
Outdoors 50%	monthly	weekly	yearly	yearly	yearly	monthly
Outdoors 75%	monthly	most days	monthly	monthly	monthly	monthly

Notes: [a] *The interquartile range lies between the 25th percentile (25%) and the 75th percentile (75%) in the charts above. The 50th percentile (50%) is the median value*
[b] *yearly = one to two times per year; monthly = one to two times per month; weekly = one to two times per week*

Table 5: Class size and time

	Overall	Non-School	All Schools	Elementary	Middle	High
Classroom computer	64%	31%	70%	77%	68%	61%
Class comp N 25% [a]	2	2	2	2	1	2
Class comp N 50%	3	6	3	3	3	6
Class comp N 75%	10	15	10	5	6	15
Classroom Internet	72%	35%	79%	79%	76%	73%
Lab Computers	82%	42%	89%	84%	90%	89%
Lab comp N 25%	24	6	24	20	24	24
Lab comp N 50%	30	20	30	28	30	28
Lab comp N 75%	30	25	30	30	30	30
Lab Internet	86%	46%	93%	85%	93%	93%
Data Software	74%	44%	80%	64%	78%	86%

Note: *"Class comp N" = number of classroom computers; "Lab comp N" = number of lab computers*
[a] *The interquartile range lies between the 25th percentile (25%) and the 75th percentile (75%) in the charts above. The 50th percentile (50%) is the median value.*

Table 6: Access to computers

Because NERRS is interested in creating materials that will use real-time data available from NOAA's System Wide Monitoring Program (SWMP), we asked about the availability

of computers in classrooms and labs, respondents' access to the Internet, and the availability of data analysis software. **Most classrooms (64%) have computers in the classroom**, though a median average of only 3 of them; 72% of these have access to the Internet. **A higher proportion (82%) of teachers have access to computer labs, which typically have 30 computers in them; 86% of these have access to the Internet.** Most teachers (74%) have access to data analysis software. **There is much less access to computers among non-school respondents**—just 31% in classrooms and 42% in labs. In addition, elementary teachers have greater access to a small number of computers in their classroom than do middle and high school teachers. (See Appendix for statistical details.)

In this section, we have described the backgrounds and characteristics of the teachers who responded to the needs assessment survey, their students, and some important characteristics of their teaching situations. While we didn't use random sampling techniques to gather a representative sample, as we have seen, many of the characteristics of the actual sample of respondents reflect, or nearly reflect, important characteristics of US teachers and schools as a whole. The differences and patterns of qualifications and experiences, types of courses taught, and access to resources we've identified above may prove useful to NERRS and other program designers.

How can we characterize…the methods and materials teachers use?

As noted above, one major goal of this needs assessment was to gather information that would inform the design of supplementary curriculum materials about estuarine topics. These new materials are more likely to be adopted if they fit—or at least do not strongly clash—with teachers' preferences about teaching methods and adoption of materials. Therefore, we gathered information about these issues, which we report in the sections below.

We asked teachers about their preferred time frames when adopting curriculum materials—that is, how likely it is they would use materials which were written to require different amounts of time. They rated their preferences on a 5-point scale (1–Wouldn't use; 2–Unlikely to use; 3–Somewhat likely; 4–Likely; 5–Definitely). In **Table 7** we report percentages who say they are Somewhat likely, Likely, or would Definitely use materials in each timeframe and the average (mean) rating in parentheses.

	Overall	Informal	Schools	Elementary	Middle	High
Single Activities	80% (3.4)	84% (3.5)	79% (3.4)	77% (3.3)	78% (3.3)	84% (3.6)
1 week or less	85% (3.5)	74% (3.2)	87% (3.5)	80% (3.4)	86% (3.5)	88% (3.6)
One 2-3 week module	75% (3.2)	56% (2.8)	79% (3.3)	79% (3.3)	82% (3.4)	76% (3.2)
Several 2-3 week modules	62% (2.9)	49% (2.6)	64% (3.0)	71% (3.2)	67% (3.1)	60% (2.9)
Full semester	47% (2.6)	49% (2.7)	47% (2.6)	53% (2.8)	44% (2.6)	49% (2.6)
Student projects	63% (3.0)	67% (3.1)	63% (3.0)	76% (3.3)	64% (3.1)	58% (2.8)

Table 7: Preferred timeframes for curriculum materials

The vast majority of educators across all settings prefer curriculum materials presented in relatively short timeframes—individual activities, one week or less of connected activities, or one 2 to 3 week module. Informal educators say they are less likely (than those in schools) to use activities that take a week, a full 2 to 3 week module, or several modules. Elementary teachers are more willing to use materials over a longer time frame—e.g., activities from several modules or a full semester of work—than are middle or high school teachers, and are also more likely to use materials to support individual student projects. High school teachers are less likely to use one or more modules, and are more likely to use single activities than are other school teachers (see Appendix for statistical details). Although longer term formats are generally less preferred, nearly 2/3 of educators in most settings (though just 50% of informal educators) say they might use several modules, and nearly half say they might use a full semester of materials. Some teachers say they want choice about how much time to spend based on their curricular needs and interests; some have preferences about when during the year they might do activities on estuaries (though there is no consensus on this).

Teaching Methods

We asked teachers about the methods they use for teaching science. We were interested in whether the inquiry type of activities that we intend to design will fit well with what teachers already see themselves doing and, therefore, the kinds of supports they might need to enact these activities in their classrooms. We asked teachers to rate how frequently they used each type of method on a 5-point scale where 1= Never; 2=Rarely (1-2 times per year); 3=Occasionally (1-2 times per month); 4=Frequently (1-2 times per week); and 5=Almost always (most days). As usual, we will present average (mean) ratings by context, level, and major subject area. **Table 8** below is ordered by frequency in high school classrooms.

Frequent teaching methods (those used more than 1-2 times per month—average ratings > 3.5) in all these settings include Hands-on activities, Lecture, Problem solving, Whole group discussion, Teacher demonstration, Recitation (students answer teacher questions), Inquiry activities, and Small group discussions. Informal educators use more

		Overall	Informal	Schools	Elementary School	Middle School	High School	Earth Science	Physical Science	Life Science	
Frequent Teaching Methods	Hands-on activities	4.07	4.54	3.99	4.11	3.98	4.01	4.00	4.01	4.04	Frequent Teaching Methods
	Lecture	3.80	3.57	3.83	3.52	3.77	3.99	3.89	3.94	4.06	
	Student problem solving	3.92	3.90	3.93	3.98	3.85	3.95	3.92	4.05	3.98	
	Whole group discussions	4.01	3.99	4.03	4.06	4.13	3.93	3.84	3.87	3.95	
	Teacher demonstration	3.82	4.00	3.79	3.83	3.76	3.78	3.85	3.78	3.78	
	Recitation	3.64	3.54	3.65	3.45	3.58	3.78	3.69	3.76	3.83	
	Inquiry activities	3.75	3.95	3.73	3.77	3.73	3.70	3.68	3.74	3.74	
	Small group discussions	3.72	3.62	3.75	3.79	3.79	3.69	3.67	3.79	3.67	
Occasional Teaching Methods	Analyze charts, graphs, maps	3.34	3.10	3.39	3.27	3.28	3.54	3.62	3.50	3.51	Occasional Teaching Methods
	Writing activities	3.36	2.86	3.47	3.36	3.44	3.38	3.33	3.32	3.45	
	Current issues	3.25	3.56	3.18	3.02	3.09	3.38	3.37	3.22	3.42	
	Create charts graphs, maps	3.21	2.90	3.27	3.12	3.18	3.36	3.38	3.39	3.37	
	Analyze images, animations	3.05	2.75	3.11	2.92	2.99	3.22	3.25	3.04	3.32	
	Performance assessment	3.13	2.90	3.16	3.07	3.11	3.20	3.18	3.20	3.22	
	Student presentations	2.99	2.91	3.02	3.11	3.06	2.96	2.91	3.04	2.96	
	Use data (Student collected or internet source)	2.61	2.57	2.62	2.50	2.58	2.75	2.81	2.75	2.75	
Rare Teaching Methods	Web quests or online activities	2.40	1.86	2.51	2.35	2.49	2.57	2.73	2.42	2.59	Rare Teaching Methods
	Case studies	2.19	2.33	2.17	1.98	2.08	2.45	2.44	2.26	2.52	
	Art, music, social studies, interdisciplinary activities	2.69	2.86	2.67	3.25	2.60	2.41	2.40	2.40	2.44	
	Field work at natural sites	2.47	3.77	2.26	2.48	2.30	2.32	2.45	2.23	2.36	
	Virtual field trips	2.17	1.78	2.24	2.31	2.19	2.21	2.40	2.11	2.22	
	Inquiry/science fair projects	2.24	2.29	2.26	2.36	2.37	2.14	2.14	2.21	2.25	
	Service learning/ stewardship	2.14	2.95	2.02	2.22	2.07	2.03	2.01	1.93	2.07	

Table 8: Teaching methods: Frequency of use

hands-on and inquiry activities, more teacher demonstration and, of course, more field work at natural sites than do those in schools. School teachers, and particularly middle

and high school teachers, use more lecture than do informal educators or elementary teachers, though lectures are still frequent in these settings. In high schools, especially in Earth science classrooms, students also frequently Analyze charts, graphs and maps.

Occasional teaching methods (those done monthly or less, but more than just 1-2 times per year—average ratings between 2.5 and 3.5) include Analysis of charts, graphs and maps, Writing activities, Discussion of current issues, Creation of charts, graphs and maps, Analysis of images or animations, Performance assessments, Student presentations, Students use of data they collected or from the internet. School teachers, and particularly high school teachers, more often ask students to create or analyze charts, graphs, or maps, and images or animations than do informal educators. Informal educators more often do stewardship activities or discuss current issues than do those in schools, and less often do writing activities. High school teachers also occasionally use Web quests or online activities, and everyone *except* high school teachers also use Art, music, social studies and other interdisciplinary activities. High school Physical science teachers analyze images and animations less often than do high school Life science or Earth science teachers. Finally, informal educators also occasionally use Service learning/ stewardship activities.

Other than the exceptions noted above, **activities done rarely** (1-2 times per year, if at all—average ratings < 2.5) include Case studies and Virtual field trips in all contexts; Science fair/ inquiry projects in schools and informal sites, Field work in schools, Art, music and other interdisciplinary activities in high schools, Online activities except in high schools, and Stewardship activities in schools. Earth sciences teachers do more online activities and virtual field trips, and fewer inquiry projects than life or physical science teachers. Physical science teachers use fewer case studies and do fewer stewardship activities than high school teachers focusing on other topics. These patterns of use may help shape the kinds of activities that are appropriate to include in curriculum materials. (See Appendix for statistical details.)

Sources for curriculum materials

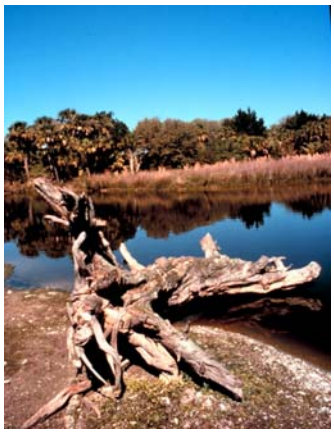
We were interested in the kinds of resources for curriculum materials and activities that educators find most useful. We asked respondents to rate how often they used each of the following types of materials on a 5-point scale (1=Not aware of this resource; 2=Aware, but never used; 3=Used once or twice; 4=Used occasionally; 5=Used regularly). We present average (mean) ratings for each context in **Table 9**.

Supplementary curriculum materials and online materials are used occasionally to regularly by all educators, though school teachers more often use supplementary materials than do informal educators. Middle and high school teachers also use textbooks, though these are less frequently used by elementary teachers and rarely by informal educators. Interactive websites are used occasionally by those in schools, and less often by informal educators. Informal educators frequently use materials from environmental education centers and field trips to these sites—elementary teachers use these to some extent, but middle and high school educators less so. Data analysis software is generally not used, except occasionally by high school teachers. Virtual field trips are rarely used by any of these respondents, though school teachers use them more than informal educators. (See Appendix for statistical details.)

Curriculum sources	Overall	Informal	Schools	Elementary	Middle	High
Supplementary curriculum materials	4.51	4.29	4.54	4.44	4.53	4.57
Online materials	4.22	4.32	4.21	4.15	4.21	4.24
Textbooks	4.04	3.13	4.17	3.60	4.16	4.33
Materials from environmental education centers	3.93	4.57	3.84	4.15	3.97	3.74
Interactive websites	3.77	3.50	3.81	3.69	3.88	3.79
Field trips to environmental education sites	3.14	4.26	2.97	3.45	2.98	2.91
Data analysis software	2.94	2.72	2.98	2.60	2.93	3.22
Virtual field trips	2.65	2.40	2.71	2.79	2.70	2.63

Table 9: Sources for curriculum materials

This section of the needs assessment report has described the types of teaching methods used by teachers in different contexts, and their preferences about time frames and formats for curriculum materials. Overall, it seems that supplementary curriculum materials provided online that are designed to take a modest (2-3 week) amount of time should fit with teachers' needs. If the curriculum includes hands-on and inquiry activities, student problem solving, and whole and small group discussions, those should be easy to fit into teachers' current practices; analysis of charts, graphs, maps and images, and use of data may be more novel and require more curriculum support.



How do estuaries, or topics related to estuaries, fit with what teachers currently teach?

In this section we'll answer the main research question above by addressing the following sub-questions: How much time do teachers currently spend teaching about estuaries? How much knowledge do they have about a range of estuarine-related topics and how likely are they to teach these? What role do field experiences currently play in their teaching? Where do they currently get information and materials related to estuaries?

Time teaching about estuaries.

We asked respondents how many days per year they currently spend teaching about estuaries, watersheds, coastal areas, and/ or oceans using a 5-point rating scale (1=Not at all; 2=1-2 days per year; 3=3-5 days per year; 4=6-15 days per year; 5=More than 15 days per year). The data are presented in **Table 10**.

On average across all sites, teachers currently spend between one and three weeks teaching about estuaries, though nearly a third of those in schools, and over half of those in informal settings spend more than three weeks each year. At the opposite extreme, nearly 1/5 of teachers currently spend no more than 1 or 2 days each year teaching about estuaries, watersheds, coastal areas and/ or oceans. Informal educators spend more time teaching about estuaries than do school teachers (the difference on average is roughly 1.5 weeks for school teachers and a little over 2.5

weeks for informal educators); school teachers at all levels spend about the same amount of time teaching about estuaries. (See Appendix for statistical details.)

	Overall	Informal	All Schools	Elementary	Middle	High
Days—Mean rating	3.7	4.1	3.6	3.7	3.8	3.6
Not at all (1)	7%	3%	8%	8%	7%	7%
1-2 Days (2)	10%	10%	11%	8%	9%	12%
3-5 Days (3)	19%	13%	20%	18%	16%	21%
6-15 Days (4)	31%	19%	32%	29%	34%	31%
15+ Days (5)	33%	55%	29%	35%	33%	28%

Table 10: Current time spent teaching about estuaries and watersheds

Not surprisingly, **educators in coastal areas spend more time teaching about estuaries than do those in non-coastal areas** (the difference on average is roughly between 1.5 weeks for non-coastal educators and 2 full weeks for coastal educators—33% more). Still, *non-coastal* informal educators spend about as much time as *coastal* school teachers teaching about estuaries (see Appendix for statistical details).

Content knowledge and likelihood of teaching

We wanted to understand which particular concepts or topics related to estuaries, watersheds, coastal areas and/ or oceans teachers are most likely to teach. We were also interested in teachers' reports of the extent of their own knowledge about each topic, as we wondered how that might affect teachers' likelihood of teaching each concept. We broke these topics into subject matter areas—Life sciences, Earth sciences, Physical sciences, Science/ research (methods), and Humans and the environment—with between 5 and 10 items in each subject area. Teachers reported their own knowledge about different topics on a 5-point scale (1-Nothing or very little; 2-Some knowledge; 3-Moderate knowledge; 4-Solid knowledge; 5-I'm an expert on this topic). They also rated their likelihood of teaching these topics on a different 5-point scale (1=Highly unlikely; 2=Unlikely (10% chance); 3=Possible (25% chance); 4=Likely (50/50 chance); 5=Highly likely/ already teach this).

We begin by reporting average (mean) ratings (using the scales, above) for Knowledge and Likelihood of teaching within broad topic areas, separating by the various contexts (**Table 11**, by different levels within schools and, for high school teachers, also by subject areas taught (**Table 12**). In **Table 11**, we order results by Likelihood of teaching in schools (which is the same as Overall):

	Overall		Informal		Schools	
	Know	Teach	Know	Teach	Know	Teach
Science/ Research	3.61	4.06	3.53	3.73	3.63	4.12
Earth Sciences	3.38	3.88	3.38	3.77	3.39	3.91
Physical Sciences	3.44	3.80	3.29	3.50	3.48	3.80
Life Sciences	3.23	3.80	3.42	4.04	3.21	3.77
Humans/ Environment	3.34	3.71	3.46	3.86	3.33	3.70

Table 11: Knowledge and likelihood to teach: Overall content areas

There are a few things to notice about these data. In all these contexts, teachers rate their knowledge as Moderate to Solid, although there is substantial variability in responses. Teachers in schools know more about the physical sciences, and informal

educators know more about the life sciences, and these differences are statistically significant. Teachers in all contexts say the likelihood of their teaching these concepts is fairly high, roughly 40–50%. Teachers in schools are more likely than those in informal settings to teach about scientific methods and research, physical sciences, and Earth sciences, and are less likely than informal educators to teach about life sciences, and these differences are statistically significant (see Appendix for details).

Analyzing school teachers' knowledge and likelihood of teaching different topics at different grade levels and major subject areas in high school, we get average (mean) ratings as in **Table 12**, below. Not surprisingly, **high school teachers (who specialize in science teaching) on average know more about any of these topics than do elementary and middle school teachers.** High school teachers are also more likely to teach the set of topics within each category (although tied with middle school teachers for Earth science, and with elementary teachers for life science). See Appendix for statistical details.

Among high school teachers, it is no surprise to find that teachers are more likely to teach the topics within their major focus area than in other areas. In addition, **biology teachers are also more likely than other high school teachers to teach about science/ research and about humans and the environment** (see Appendix for statistical details). These differences may have implications for the design of materials and intended audiences.

	Schools						High Schools Only					
	Elementary		Middle		High		Earth Science		Physics/ Chemistry		Biology	
	Know	Teach	Know	Teach	Know	Teach	Know	Teach	Know	Teach	Know	Teach
Science/ Research	3.24	3.65	3.58	4.11	3.86	4.34	3.81	4.31	3.94	4.43	3.90	4.45
Physical Sciences	2.98	3.28	3.46	3.75	3.77	4.14	3.77	4.23	3.93	4.24	3.74	4.11
Earth Sciences	3.18	3.74	3.43	3.97	3.50	3.94	3.75	4.48	3.42	3.66	3.48	4.02
Life Sciences	3.05	3.84	3.18	3.71	3.37	3.84	3.26	3.86	3.22	3.52	3.56	4.28
Humans/ Environment	3.20	3.61	3.33	3.70	3.44	3.80	3.49	3.92	3.31	3.59	3.51	3.91

Table 12: School teachers' knowledge and likelihood to teach by level and high school content focus

Content details

Differences in these overall categories are informative. However, in fact, teachers responded differently to the specific items within the larger subject domains. **Table 13** details the item-by-item responses within the larger subject areas, and include the average for each subject area as the final item, for comparison purposes. It displays results overall (for all respondents), but a breakdown for educators in different contexts and at different levels in schools can be found in the Appendix. Items are sorted within each subject section by likelihood to teach that topic.

Although teachers are quite likely to teach all of the Life Sciences topics, there is, on average, a greater than 50/50 chance that they will teach *Biodiversity and adaptation* and *Nutrient cycles and food webs* and somewhat less likelihood they'll teach the other topics.

Teachers at all levels are quite likely to teach most of the topics in the Earth science category, including *The water cycle*, *Wetlands, rivers and watersheds*, and *Erosion and sedimentation*.

Area	Item	Know	Teach
Life Sciences	Nutrient cycles & food webs	3.56	4.16
	Biodiversity & adaptation	3.56	4.13
	Marine habitats	3.22	3.86
	Invasive species	3.08	3.64
	Life cycles of marine organisms	3.08	3.61
	Animal migration	3.09	3.59
	Estuaries as marine life nurseries	3.02	3.58
	Life Sciences Average	**3.23**	**3.80**
Earth Sciences	Hydrologic/ water cycle	3.77	4.30
	Wetlands	3.53	4.11
	Rivers & watersheds	3.49	4.09
	Erosion & sedimentation	3.53	4.05
	Weather	3.36	3.85
	Geological change	3.33	3.83
	Earth Systems	3.36	3.82
	Climate change or sea level rise	3.29	3.77
	Tides & the intertidal zone	3.14	3.55
	Ocean currents	3.02	3.42
	Earth Sciences Average	**3.38**	**3.88**
Physical Sciences	Physical properties of water	3.70	4.05
	Water density	3.42	3.72
	Heat transfer	3.45	3.70
	Water chemistry	3.31	3.65
	Salinity	3.32	3.58
	Physical Sciences Average	**3.44**	**3.74**
Science/ Research	Experimentation & scientific method	3.99	4.52
	Lab or field work techniques	3.69	4.19
	Data analysis	3.60	4.09
	Technology & instrumentation	3.39	3.83
	Interdisciplinary research	3.38	3.66
	Science/ Research Average	**3.61**	**4.06**
Humans & the Environment	Human impact on the environment	3.78	4.42
	Conservation	3.70	4.33
	Water pollution	3.61	4.27
	Water quality monitoring	3.34	3.73
	Coastal erosion	3.11	3.45
	Coastal hazards	3.10	3.24
	Recreation	3.29	3.24
	Commercial fishing & fisheries	2.81	2.99
	Humans & the Environment Average	**3.34**	**3.71**

Table 13: Content knowledge and likelihood to teach details

In the physical sciences category, only *Physical properties of water* is rated as a having a 50% or above chance of being taught. However, there are substantial differences between contexts and levels both in knowledge and likelihood of teaching these topics. See Appendix for details.

In the Science/ research category, educators at all levels say they are quite likely to teach about *Experimentation & scientific method* and, except for elementary teachers who rate it somewhat less likely, *Lab or field work techniques*.

When considering issues about Humans and the environment, educators in all contexts and at all levels say they are likely to teach about *Human impact on the environment*, *Water pollution* and *Conservation*.

Field work

The ability to take students into the field to study natural sites is a potentially important component of a curriculum about estuaries. **We asked respondents how many times each year they bring students to natural areas to do field work or go on field trips. Answers varied dramatically, ranging from not at all to every day, though 85% of educators do field work with students no more than once a month. Figure 3**, below shows the distribution of this large majority of educators—the median value is 2 visits per year.

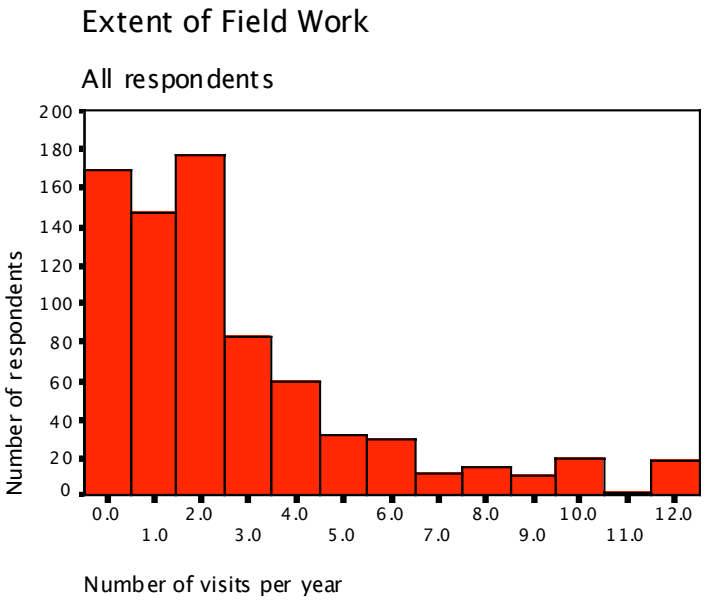


Figure 3: Number of annual field work visits

Teaching context has a huge impact on the importance of field work in educators' work. The median number of trips for informal educators is 12—once a month—and a full 25% of such educators report doing field work every day. For school teachers overall, the median is 2 times per year with 21% saying they don't go at all, and the top 25% only going 4 or more times—this description is fairly accurate for school teachers at all levels. These differences are statistically significant (see Appendix for details). Within each context group, we tested whether coastal location affected the number of field work experiences per year, and found no statistically significant differences in either context.

When educators take students into the field, they have different amounts of time to do so. We asked respondents how long their trips to natural areas last—they could check more than one response, though most seemed to pick just one (see **Table 14**). **Over half of informal educators and elementary teachers, and a plurality of middle and high school teachers, say they go on field trips or do field work for a whole day, with a substantial fraction saying they take half day trips.** This is somewhat less true for middle and high school teachers, who often only have a single class period for field work/ field trips. Overnight trips are rare in all contexts, although informal educators use them more frequently than school teachers. (See Appendix for statistical details.)

Time Period	Overall	Informal	Schools	Elementary	Middle	High
One class period	23%	14%	24%	16%	23%	30%
Half day	19%	34%	17%	20%	15%	19%
Whole day	44%	54%	44%	55%	45%	40%
Overnight	8%	14%	7%	6%	6%	8%
Not at all	14%	5%	15%	12%	16%	14%

Table 14: Time spent in the field

We were interested in the kinds of activities teachers do with students when they take them into the field. We asked them to rate how frequently they do each of the following activities using a 5-point scale (1=Never; 2=Rarely; 3=Occasionally; 4=Frequently; 5=Almost always). In **Table 15**, we present the percentage of educators in each group who do each activity Frequently or Almost always.

Activity	Overall	Informal	Schools	Elementary	Middle	High
Making observations	90%	97%	89%	89%	91%	89%
Measuring/ collecting data	68%	71%	69%	57%	71%	75%
Analysis or interpretation of data	64%	66%	64%	52%	63%	63%
Gathering specimens	52%	62%	50%	43%	51%	52%
A tour or presentation by an environmental educator/ specialist	54%	79%	49%	69%	49%	44%
Doing stewardship activities	33%	55%	30%	34%	32%	32%

Table 15: Activities in the field

When doing field work, the vast majority of respondents say they make observations and most measure or collect data, and analyze or interpret data. Informal educators more often make observations, gather specimens, include a tour or presentation by an environmental educator, and do stewardship activities than do those in schools. Elementary educators less often collect or analyze data than do middle or high school teachers. Middle and high school teachers less often include a tour or presentation by an environmental educator than do elementary teachers—perhaps because, as we saw above, their field work is somewhat more often confined to a single class period rather than a half or whole day excursion (see Appendix for statistical details). In open-ended responses, teachers note that the observations and data collection activities can be sketches, photographs, or video as well as written notes; that they often ask students to use field guides to identify specimens, and that they have discussions and do other follow-up activities in class. Culturally linked activities—explorations of history and local culture, as well as creative poetry, art, music & dance activities—play an important role in field work, as does just being outdoors and doing outdoor activities such as hiking, swimming or boating.

We asked which websites respondents use to find educational resources about estuaries and coastal issues. The percentages of respondents in each category who said they used each resource are listed in **Table 16** ordered by high school teachers' preferences. There are only a few sites that are used differently by teachers in different contexts and at different levels. Informal educators use the NERRS.NOAA.gov and the EPA Estuary program sites more than do school teachers; teachers in schools use the NOAA Discovery Center, NSTA, Scholastic, ERIC and Yahoo more than do informal educators. In comparing use of websites by school level, NOAA Education websites, the NSTA website, and the US Geological Survey website are used more by teachers of older grades; Scholastic is used substantially more by elementary educators and almost not at all by high school teachers; and The Bridge is used less often by middle grades

teachers than by those at other levels (but we don't know why). Other differences in frequency of use are not statistically significant (see Appendix for details).

Teachers also suggested over 200 other sites that they use as resources. To give a sense of these, those mentioned by 3 or more people (some of which repeat those in the table above) include UnitedStreaming.com mentioned by 10 teachers, Centers for Ocean Science Education Excellence (COSEE, and COSEE-West) (8), Chesapeake Bay Foundation (6), pbs.org (and Nova) (6), dlese.org (5), GLOBE (5), Jason Project (5), US Fish & Wildlife Service (5), American Meteorological Society (4), ask.com (4), Project WET (4), US Geological Survey (4), National Wildlife Federation (4), Access Excellence (3), BrainPOP (3), BTNEP.org (3), dogpile search engine (3), Padilla Bay Estuary (3), Project Wild (3), US Environmental Protection Agency (3), and the Virginia Institute of Marine Science (VIMS) (3). There are a wide range of other sites mentioned, including a variety of state and local organizations and institutions.

Websites	Overall	Informal	Schools	Elementary	Middle	High
Google	73%	77%	73%	73%	72%	72%
NOAA Education website	59%	60%	59%	52%	59%	64%
National Geographic	47%	45%	49%	49%	46%	50%
NSTA	40%	30%	43%	32%	45%	46%
US Geological Survey	41%	47%	40%	27%	44%	45%
NASA	42%	35%	43%	40%	45%	41%
State Educational sites	40%	47%	39%	42%	41%	34%
NOAA Discovery center	27%	22%	28%	24%	27%	29%
Yahoo	30%	22%	31%	34%	32%	27%
Estuaries.gov	23%	27%	23%	23%	21%	23%
EPA National Estuary program	23%	33%	21%	21%	21%	22%
The Bridge (NMEA)	14%	18%	13%	13%	9%	19%
oceanslive.org	17%	19%	16%	18%	16%	17%
ERIC	14%	10%	15%	13%	14%	15%
NERRS.noaa.gov	14%	19%	13%	13%	12%	13%
Scholastic	17%	11%	19%	35%	19%	6%
Other website	19%	27%	18%	21%	20%	18%

Table 16: Websites used to find educational resources by context and teaching level

We were interested in whether educators had used specific NOAA or NERRS materials in their courses. Again, these are presented in **Table 17** according to the percentages of educators in different contexts who said they had used the materials. Only two of these are used differently by Informal and School based educators—NOAA's severe storm lab which is used substantially more in schools than in informal settings, and MERITO (though the numbers using this are so small that the results may be erratic).

Teachers listed a variety of other sources for curriculum materials. Prominent among these were materials from Project WET (18), Project Wild (10), Aquatic Project Wild (8), Project Learning Tree (4), US Geological Survey (4), and Wonders of Wetlands (WOW) (4).

Materials	Overall	Informal	Schools	Elementary	Middle	High
Other NOAA data sites	25%	22%	26%	22%	24%	31%
Project WET Bays & Estuaries	24%	32%	23%	32%	23%	21%
NERRS website materials	15%	18%	14%	12%	14%	15%
NOAA Severe storm lab	13%	7%	14%	12%	14%	15%
EstuaryLive	13%	11%	14%	15%	14%	13%
Watersheds weather curriculum	16%	22%	15%	16%	18%	13%
NERRS sites, materials	14%	16%	14%	12%	14%	12%
Jetstream	9%	7%	10%	6%	11%	10%
Estuary Net	7%	7%	6%	6%	5%	8%
NOS Estuaries tutorial	5%	8%	5%	8%	4%	5%
NOS Tides	3%	4%	3%	3%	3%	4%
Grasses in classes	4%	6%	4%	5%	4%	4%
SWMP	3%	3%	3%	2%	2%	3%
Nab Aquatic Invader	3%	3%	3%	2%	4%	3%
Green eggs and sand	2%	3%	2%	3%	1%	2%
MERITO	1%	0%	1%	1%	1%	1%
Brant Monitoring project	0%	0%	0%	0%	0%	0%
Other materials	9%	15%	8%	8%	8%	10%

Table 17: Use of NOAA/ NERRS materials

Data from this section of the needs assessment show that a majority of educators across contexts and teaching levels currently spend one to three weeks or more teaching about estuaries, watersheds, coastal areas and/ or oceans, with those *in* coastal areas spending somewhat more time than those not in coastal areas. We explored teachers' self-assessed content knowledge about a variety of estuarine-related topics—in general, rated moderate to strong—and their likelihood of teaching these—in general, rated possible to likely—noting differences between school and informal educators and between teachers at different levels. We also described the extent to which educators use field work experiences in their teaching and the types of field activities they engage in, noting substantial context and level differences, but no coastal/ non-coastal differences. Finally, we described information about the types of resources—websites and NOAA/ NERRS materials—that educators use.

How can estuarine-related curriculum materials and professional development be designed to increase the likelihood that they'll be used?

In this section we'll answer the main research question above by addressing the following sub-questions: What are teachers reasons/ goals in selecting supplementary curriculum materials? What supports and obstacles do teachers perceive they have in adopting new curriculum materials? What are teachers' preferences for delivery of materials? What are their needs for professional development training and their preferences for its delivery?

Reasons for incorporating supplementary materials.

We asked teachers to rank in order of importance (on a scale of 1-5) several reasons for incorporating supplementary materials into existing curricula. We present their average rankings by context in **Table 18**. **The order of the average rankings was the same for all these contexts and levels—"increasing student interest through authentic contexts" first**; "providing more in-depth coverage of a particular topic" next, followed in turn by "addressing inquiry standards" and "replacing sections of an existing curriculum to better cover specific concepts", although elementary teachers and informal educators ranked these last two essentially the same (see Appendix for statistical details).

Topic	Overall	Informal	Schools	Elementary	Middle	High
To increase student interest with interdisciplinary and/ or authentic contexts	4.17	4.19	4.17	4.16	4.18	4.16
To provide more in-depth coverage of a particular topic	3.52	3.72	3.48	3.55	3.51	3.41
To address inquiry standards in ways that an existing curriculum does not	3.24	2.96	3.29	3.14	3.36	3.29
To replace sections of an existing curriculum to better cover specific concepts	3.16	2.98	3.18	3.15	3.15	3.16
Other	1.45	1.79	1.42	1.55	1.55	1.36

Table 18: Goals for including supplementary materials

There were a few additional themes in the open-ended responses. A number of teachers see supplementary materials helping them address varied student needs, that is, they're looking for materials that "*Allow for differentiated instruction to address the wide range of student needs and abilities and learning styles*." Teachers see these materials providing alternatives to their everyday ways of teaching, for example, through *hands-on*, *project-based*, *student-led*, or *experiential* activities, or by helping them "*incorporate the most modern technology into our studies*." Teachers hope these kinds of materials will "*make things more interesting*," or "*fun and engaging*" for students, and that they'll "*make students love science*." In addition, they hope these materials will "*Keep the teacher fresh, too!*" providing an opportunity to do something interesting and different. Some teachers see supplementary materials helping them make local issues more relevant to students. Finally, a few teachers see a larger purpose for these types of materials, saying they're looking for "*Anything that will make learning come alive and aid us in cultivating the next generation of environmentalists.*"

Reasons to teach or not teach a topic

Teachers gave open-ended responses to two questions asking about the major reasons why they would be likely/ unlikely to teach a particular estuarine related topic. There are a variety of reasons why teachers might teach a topic. Chief among these is that it meets the requirements of their state or local curriculum or the state standards, or is tested on state tests (over 40% of all categorized responses). Teachers are also very interested in topics that are relevant to the world and their local communities, and that help students understand human impact on the environment and develop into responsible citizens who

can make a difference about important global issues (25% of responses). They want topics that are interesting to students and to themselves, that build on what they know (14% of responses), and that use hands-on and field/ lab experiences and are integrated across subject areas (7%).

Many of the reasons teachers might *not* teach about a topic mirror the reasons above. In particular, a huge proportion (over 50% of categorized responses) feel a keen lack of time to add any materials that are not already in the required curriculum or standards, or covered on tests. Teachers also worry they may not have enough knowledge about a topic to teach it (15% of respondents), about the availability of necessary materials and equipment or funds (over 10% of respondents), and whether the materials are interesting or at the appropriate level for their students (about 7%). Many (8%) say they wouldn't teach coastal topics because of their location away from the coast. A few (2%) insisted that they would teach all topics or that they would learn what they had to so as not to keep them from teaching important topics.

Supports and obstacles to adopting new curriculum materials

This section was designed to help us know more about where teachers look for supports in implementing new curricular materials, and where they encounter obstacles. We asked a variety of questions, grouped into several categories—Standards, testing & policy; Curriculum; People; Teachers' professional knowledge; Professional development; Technology; and Field work. Items within each of these categories were rated on a 5-point scale centered on 0, ranging from –2=Strong obstacle, –1=Moderate obstacle, 0=Neither an obstacle nor a support, 1=Moderate support to 2=Strong support. In **Table 19** we report average ratings for each area, by context and level.

Supports & Obstacles	Overall	Informal	Schools	Elementary	Middle	High
Teachers' Professional Knowledge	1.02	1.01	1.03	0.87	0.97	1.13
People	0.57	0.92	0.53	0.67	0.54	0.49
Technology	0.13	0.12	0.14	0.20	0.06	0.15
Professional Development	0.00	0.16	-0.03	-0.01	-0.05	0.02
Standards, Testing & Policy	0.01	0.06	0.01	0.01	0.05	0.01
Curriculum	0.02	0.10	0.01	0.02	0.03	-0.01
Field Work	-0.41	0.04	-0.48	-0.26	-0.51	-0.47

Table 19: Supports and obstacles: Broad categories

Across the board, **teachers see their own knowledge—about science content, teaching inquiry science, working with data, and hands-on labs—as a moderate to strong support for adopting new materials**, with high school teachers rating this the highest. **People—including principals/ department chairs, student interest, colleagues, outside experts, and parents—are also seen as a support**, with informal educators rating this more highly than school teachers, and a (statistically demonstrated) sense that these are somewhat less supportive at higher than lower grades. **Issues around technology**—access to computers, software and the internet, and availability of lab equipment or supplies, funds to purchase these, and teachers' comfort with technology—**are seen as a slight support** with middle school teachers less enthusiastic

about this than either elementary or high school teachers. **For all educators other than informal educators, issues around field work**—distance to an estuary, field trip policies, cost of transportation, time needed for field work preparation, student behavior outside of school, and teachers' confidence in facilitating field work—**are a slight to moderate obstacle**, with elementary level teachers finding this slightly less of an obstacle than middle or high school teachers. **Issues around Standards, testing and policy; curriculum; and availability of professional development are, on average, seen as neither an obstacle nor a support,** and teachers' perceptions about these do not differ by context or level taught (see Appendix for statistical details).

In addition to the variability in average responses, described above, there are some differences within these broad categories in what are perceived as supports and obstacles. In **Table 20** through **Table 26**, below, we present educators' ratings on the separate items contributing to the averages above, again distinguishing by context and grade level.

Standards, testing, policy	Overall	Informal	Schools	Elementary	Middle	High
Science Standards (National, state or district level)	0.20	0.19	0.20	0.31	0.26	0.11
The value placed on teaching science compared to other subjects at my school/ organization	0.18	0.39	0.16	-0.03	0.17	0.32
Other school or district policies	-0.09	-0.16	-0.08	-0.09	-0.07	-0.11
Standardized tests in science	-0.24	-0.21	-0.25	-0.17	-0.17	-0.29
STP Average	**0.01**	**0.06**	**0.01**	**0.01**	**0.05**	**0.01**

Table 20: Supports and obstacles: Standards, testing & policy detail

There are some interesting differences in perceptions of the impact of standards, testing and policy, despite the neutral average rating. In fact, **the value placed on teaching science is generally seen as a support except among elementary teachers where it's neutral.** Still, in open-ended responses, several teachers see the "*high stakes testing emphasis on reading and math*" as an obstacle. **Science standards are also seen as a support across all levels and contexts,** with the slightly smaller ratings at high school than at elementary school levels not statistically different from chance variation. These slight supports are balanced by teachers' sense that **standardized tests are a slight obstacle** to implementation of new curriculum (see Appendix for statistical details).

Curriculum	Overall	Informal	Schools	Elementary	Middle	High
The number of opportunities for my students to develop inquiry skills	0.50	0.52	0.51	0.49	0.52	0.48
Science curriculum requirements	0.18	0.25	0.17	0.24	0.20	0.10
Availability of other curriculum materials	0.09	0.34	0.04	0.06	0.09	0.03
Availability of assessments	-0.10	-0.14	-0.09	-0.14	-0.11	-0.08
Funds to purchase curriculum materials	-0.57	-0.48	-0.59	-0.59	-0.60	-0.59
Curriculum Average	**0.02**	**0.10**	**0.01**	**0.02**	**0.03**	**-0.01**

Table 21: Supports and obstacles: Curriculum detail

Table 21 describes differences within the larger "Curriculum" area. Again, within an area where the average shows it's neither an obstacle nor a support, we find some items, such as **"The number of opportunities for students to develop inquiry skills" seen as a slight support** by all teachers, while items like **"Funds to purchase curriculum materials" (or presumably, the relative lack thereof) is seen as a slight to moderate obstacle**. Informal educators see the availability of curriculum materials as a slight support whereas school teachers see this as neither an obstacle nor a support. There are no other major differences across contexts or levels (see Appendix for statistical details).

People	Overall	Informal	Schools	Elementary	Middle	High
My principal, department chair or program director	0.82	0.98	0.82	0.79	0.89	0.84
Colleagues in your school or program	0.70	1.20	0.63	0.71	0.61	0.67
Student interest	0.65	0.98	0.62	1.00	0.59	0.45
Availability of educators or experts from other institutions	0.40	0.95	0.32	0.50	0.33	0.33
Parents	0.28	0.52	0.24	0.32	0.26	0.18
People Average	**0.57**	**0.92**	**0.53**	**0.67**	**0.54**	**0.49**

Table 22: Supports and obstacles: People detail

Table 22 concerns educators' views on the support offered by different groups of people. While **all educators, on average, see their principal, department chair or program director as a moderate support**, informal educators generally see a range of other people as more supportive than do those in schools. It's interesting that **elementary teachers see student interest as a moderate support, while middle and high school teachers see student interest as only a slight support.** (See Appendix for statistical details.) In open-ended responses, it's clear that sometimes district-level (rather than school- or department-level) administrators can also be obstacles to curriculum implementation.

Teacher professional knowledge or skills	Overall	Informal	Schools	Elementary	Middle	High
My knowledge/ experience with hands-on labs	1.13	1.13	1.12	0.98	1.07	1.22
My own knowledge of science content	1.09	1.19	1.08	0.96	1.02	1.20
My knowledge about teaching inquiry science	1.01	1.01	1.01	0.89	0.97	1.07
My own knowledge about working with data	0.86	0.70	0.89	0.64	0.81	1.02
Knowledge Average	**1.02**	**1.01**	**1.03**	**0.87**	**0.97**	**1.13**

Table 23: Supports and obstacles: Knowledge detail

Generally, teachers see their knowledge about content and teaching hands-on labs and inquiry science as a moderate support. Except for the area of inquiry science where things are roughly equal, high school teachers are more confident in their knowledge than middle school and elementary teachers, especially around working with data. (See Appendix for statistical details.)

Professional development/ Training	Overall	Informal	Schools	Elementary	Middle	High
Availability of training opportunities about inquiry science teaching	0.12	0.19	0.11	0.07	0.09	0.17
Availability of training opportunities about estuarine science content	-0.13	0.13	-0.17	-0.10	-0.20	-0.14
PD Average	**0.00**	**0.16**	**-0.03**	**-0.01**	**-0.05**	**0.02**

Table 24: Supports and obstacles: Professional development & training detail

Teachers rated this area as an overall neutral. However, teachers in schools describe somewhat more availability of training about inquiry science teaching than about estuarine science content, whereas informal educators rate these the same. (See Appendix for statistical details.)

Technology	Overall	Informal	Schools	Elementary	Middle	High
My comfort level in using technology	0.83	0.64	0.86	0.80	0.79	0.86
Access to the Internet	0.59	0.34	0.63	0.75	0.55	0.60
Access to computers	0.35	0.23	0.38	0.58	0.28	0.35
Access to software	-0.09	0.05	-0.11	-0.06	-0.20	-0.04
Availability of lab equipment or supplies	-0.17	-0.01	-0.20	-0.19	-0.26	-0.18
Funds to purchase lab equipment or supplies	-0.70	-0.54	-0.72	-0.68	-0.78	-0.66
Technology Average	**0.13**	**0.12**	**0.14**	**0.20**	**0.06**	**0.15**

Table 25: Supports and obstacles: Technology & equipment detail

In the technology category, across all contexts, there is a balancing of slight to moderate supports from teachers' perceived comfort with technology and access to the Internet and computers, with slight to moderate obstacles in the lack of availability of lab equipment and supplies and especially the funds to purchase them. Those in schools have somewhat more access to computers, and especially to the Internet, than do informal educators. Surprisingly, elementary teachers describe somewhat *more* access to computers and the Internet than do teachers in middle schools and, to a lesser extent, high schools. (See Appendix for statistical details.)

Field Work	Overall	Informal	Schools	Elementary	Middle	High
My confidence in facilitating field work	0.51	1.01	0.44	0.49	0.39	0.54
Student behavior outside of school	0.03	0.25	0.00	0.18	-0.07	0.00
Field trip policies in my school or program	-0.55	-0.06	-0.62	-0.40	-0.60	-0.66
Distance to an estuary	-0.59	-0.06	-0.68	-0.27	-0.73	-0.76
Time needed for field work or preparation for field work	-0.80	-0.28	-0.88	-0.60	-0.89	-0.88
Cost of transportation for field work	-1.06	-0.71	-1.11	-0.98	-1.16	-1.10
Field Work Average	**-0.41**	**0.04**	**-0.48**	**-0.26**	**-0.51**	**-0.47**

Table 26: Supports and obstacles: Field work detail

In the area of field work, informal educators respond more positively, or at least, less negatively, to all the items compared with other educators. **All educators see slight (moderate for informal) support in their own confidence in facilitating field work. However this is offset by a variety of slight to moderate (neutral to very slight for informal educators) obstacles including field trip policies, distance to an estuary, and time needed to prepare for field work.** Open-ended responses also mention other issues around field trips: Problems in finding acceptable parent/ chaperones, money to fund trips especially in low-income areas, and liability issues in taking students off school grounds. High school teachers have somewhat more confidence in their ability to facilitate field work than do middle school teachers; and, for unclear reasons, elementary teachers also see distance to an estuary as a smaller obstacle than others. All educators see the cost of transportation for field work as a moderate obstacle. (See Appendix for statistical details.)

Curriculum formats

To be sure that new curriculum materials will be delivered to teachers in a form they can use (balancing other considerations such as cost to produce materials in different forms, etc.) we asked teachers about their preferred ways of receiving curriculum materials or learning about new activities. They rated each of these on a 4-point scale (1=Not useful; 2=Somewhat useful; 3=Useful; 4=My preferred method of getting materials). We report these overall and by contexts and levels in **Table 27**.

Curriculum Formats	Overall	Informal	Schools	Elementary	Middle	High
Materials delivered as kits for conducting hands-on explorations	3.38	3.32	3.41	3.48	3.42	3.31
Materials delivered on a CD or DVD	3.26	3.23	3.27	3.17	3.28	3.29
Materials that can be downloaded from the web	3.23	3.33	3.22	3.14	3.24	3.27
Print materials in a binder, book or booklet	3.20	3.24	3.19	3.19	3.19	3.21
Interactions with scientists, environmental educators, or specialists at your school	3.05	3.18	3.06	3.25	3.07	2.99
Interactions with scientists, environmental educators, or specialists at field sites	2.98	3.37	2.93	3.11	2.98	2.86
Data that can be downloaded from the web	2.94	2.88	2.95	2.83	2.95	3.02
Activities done directly on an interactive website	2.81	2.34	2.89	2.69	2.87	2.91

Table 27: Curriculum formats preferences

Across the settings, all these formats are rated as useful, with **kits, CDs/ DVDs, web-downloadable and print materials viewed as most useful.** Informal educators find activities done directly on an interactive website only somewhat useful, while school teachers find these more useful. Informal educators find interactions with scientists or specialists in the field to be much more useful than do those in schools, especially high school teachers. There are also differences among school teachers in how useful these formats are: High school and middle school teachers find materials downloaded from the web, delivered on a CD or DVD, or done on an interactive website more useful than do elementary teachers. High school teachers find web-downloadable data more useful than do teachers of middle school and especially elementary grades. Elementary and

middle grades teachers find materials delivered as kits more useful than do high school teachers. There is also a tendency for teachers of younger grades to prefer interactions with scientists at schools or field sites more than do teachers of older grades. (See Appendix for statistical details.) In open-ended comments, several educators said they like to receive materials connected with professional development workshops for themselves.

Professional development

We were interested in teachers' sense of how necessary or useful different types of professional development support would be if they were to incorporate new curriculum materials into their teaching. Teachers rated each support on a 4-point scale (1=Not needed; 2=Somewhat useful; 3=Definitely needed/ useful; 4=Essential). We present average (mean) ratings for each potential need in **Table 28**.

Professional Development Topics	Overall	Informal	Schools	Elementary	Middle	High
Making new studies relevant to students' lives and concerns	2.98	3.03	2.98	3.11	3.04	2.87
Integrating new studies into existing curriculum or fit with existing standards	2.96	2.89	2.98	3.11	3.03	2.84
Developing my own understanding of new science content	2.84	2.89	2.84	2.99	2.94	2.71
Incorporating new lab activities	2.80	2.64	2.83	2.84	2.86	2.74
Orienting students to natural study sites	2.77	2.71	2.79	2.91	2.86	2.63
Facilitating field work (observing, collecting data, gathering specimens)	2.74	2.72	2.75	2.84	2.86	2.59
Doing hands-on activities	2.72	2.77	2.72	2.98	2.75	2.59
Facilitating inquiry activities	2.70	2.69	2.71	2.84	2.78	2.61
Analyzing data	2.63	2.65	2.63	2.75	2.72	2.50
Using real-time or archived data from scientific monitoring sites	2.62	2.49	2.62	2.51	2.72	2.58
Using computer-generated visualizations of data	2.62	2.38	2.66	2.65	2.78	2.54
Using software tools such as Excel, Fathom, LoggerPro, or InspireData	2.55	2.34	2.59	2.56	2.69	2.52
Using new Websites	2.46	2.18	2.50	2.60	2.58	2.34
PD Average	**2.72**	**2.64**	**2.74**	**2.82**	**2.82**	**2.62**

Table 28: Professional development topics

All these types of professional development seemed moderately useful to teachers, with support for making new curriculum relevant to students, integrated into existing curricula/ standards, and incorporating new labs, as well as developing teachers' own science content rated highest. Informal educators say that support around using data visualizations, software tools and websites, as well as incorporating new lab activities is less useful to them than it is to those in schools—which makes sense given their more limited access to computers. High school teachers rated the need for most types of professional development lower than other school teachers; middle school teachers expressed special interest in professional development around the use of real-time data,

use of visualizations of data, and use of data analysis software. (See Appendix for statistical details.)

We asked teachers about their preferred time frames and formats for professional development supports. These were rated on a 4-point scale (1=Not useful; 2=Somewhat useful; 3=Useful; 4=Very useful). We present average ratings in **Table 29**.

PD Formats	Overall	Informal	Schools	Elementary	Middle	High
Single after school workshop	2.50	2.68	2.48	2.66	2.48	2.46
Series of after school workshops	2.53	2.66	2.52	2.69	2.54	2.47
Focused 1-day workshop	3.16	3.34	3.15	3.21	3.16	3.12
Focused 2- or 3-day workshop	3.07	2.99	3.09	3.09	3.17	3.03
Extended training of 1 week or more (likely during the summer)	2.90	2.42	2.99	2.86	3.05	2.90
Consulting support over time	2.97	2.92	3.00	2.98	3.08	2.93
Online training or course	2.69	2.61	2.70	2.70	2.70	2.68
Online peer discussion group	2.26	2.24	2.27	2.32	2.23	2.26
Semester long course	1.90	1.73	1.93	1.99	1.92	1.88

Table 29: Professional development formats

Across the board, teachers preferred a focused 1-day, or 2-3 day workshop, as well as consulting support over time, with informal educators showing a stronger preference for one day workshops than school teachers. Those teaching in schools also see an extended 1 or more-week training as useful, while informal educators find it less so. After school workshops, singly or in series, and online training courses were seen as moderately useful. An online peer discussion group, and especially a semester long course were seen as only somewhat useful, with informal educators finding a semester long course less useful than school teachers. Among those teaching in schools, elementary teachers find single after school workshops somewhat more useful than do middle or high school teachers. (See Appendix for statistical details.) In open-ended comments, several teachers mentioned the importance of receiving course credit for professional development work, and of difficulties getting coverage to leave the classroom for professional development opportunities during the school day.

Results in this section suggest that teachers are looking for curriculum materials that will provide authentic contexts to help students learn about important issues, especially if these are interesting to students and teachers, and are connected to existing curriculum requirements. Teachers feel more confident when they know more about the topics—but they generally rate their knowledge fairly highly—and when all the necessary materials and equipment are readily available. Teachers find a variety of supports for implementing new curriculum materials, and a few obstacles, particularly in the area of doing field work. Web downloadable and print materials, as well as kits and CDs/ DVDs are useful to teachers. To support the use of new materials, teachers are looking for short term (1 to 3 day) professional development opportunities focused on making new curriculum relevant to students, integrating activities into existing curricula/ standards, incorporating new labs, and developing their own science content knowledge.

Open-ended responses

We gave teachers an opportunity to tell us "anything else" that they thought we should know about their situation or concerns. Of the 988 respondents, 277 (28%) provided some feedback even here, at the very end of the survey. Many elaborated on previously addressed themes of lack of time or funds, and the need to shape their teaching to fit within the constraints of prescribed curricula, state standards, and tests. It is no surprise in the current policy climate that these are very salient features of schooling. One teacher succinctly summarized a typical reality for teachers: *"What I need or want I buy on 'my dime,' off eBay!!"* Others talked about the importance of materials and programs that were inexpensive or free. However, we also heard a variety of other ideas and comments that went beyond the rest of the survey—suggestions about content or pedagogy or professional development structures; concerns that we hadn't addressed; and details about teachers' situations that help bring context and life to some of the more dry, numerical ratings. In this section, we present a summary of these comments, with some example quotes.

Some teachers told us more about themselves and their own life experiences, to help us understand their situations and put their comments into perspective, especially if they thought they might be different from the "typical" teacher. For example, several teachers described how growing up near the coast gave them an awareness of coastal issues even though they now live and work inland. We heard about teachers' prior work—as a naturalist or as a researcher in a Fortune 50 company or in a zoo—and how that affected teachers' knowledge or commitment to teaching about environmental issues. People described the impact of being at different places in their careers—a new teacher looking for good materials and collegial support; a teacher near retirement wanting to solidify the environmental course offerings in his department. A number of informal educators noted that the survey seemed primarily designed for classroom teachers and that their responses might be a little "off", with several hoping this didn't adversely affect our results. These and other biographical details reminded us (again) of the diverse situations and experiences teachers bring to their work.

There were many teachers who seemed excited about the potential in the *Estuaries 101* materials based on the questions we were asking (and what they knew about NERRS programming) and wanted to use the materials when they become available. For example:

"I would be delighted to get any material on estuaries and watersheds."

"These materials would be highly beneficial to our program!"

"This sounds like a great program"

"I would love to be part of the program"

"This will be incredibly useful to my students and our area."

"Thanks for your efforts in promoting environmental education."

The content and goals of the curriculum were a concern for many. Several teachers suggested that watersheds were a more important topic to them than estuaries. For example, *"Anything relating to watersheds would be more useful,"* and *"Don't forget the watershed!"* A few wondered whether the curriculum would also address lakes and rivers or *"…our freshwater seas, i.e., the Great Lakes."* These comments reflect the concerns we've seen earlier from those who are not located on the coasts.

Teachers are interested in helping students develop a sense of environmental awareness and concern at a variety of age levels. Again, this is similar to the concerns for promoting awareness of human impact on the environment and a desire for stewardship we've seen before.

> *"I feel it is very important for students to respect the environment and know what happens when it is not taken care of and what needs to be done to insure a healthy planet for future generations."*
>
> *"My department feels that making our students aware of the environmental impact that we have had on our oceans, estuaries, rivers, forests, etc. is of grave importance."*
>
> *"I'd also like to help them be more environmentally aware and to empower them to become environmentally active."*
>
> *"I believe that it is very important to expose students at an early age to the wonders and beauty of science. They have a natural love for animals, plants and the outdoors and it should be cultivated from preschool on up."*

Teachers are also interested in helping students learn to *"think scientifically"* and *"to love science."* They want students to have experiences *"doing what real scientists do"* including *"team work, collaboration, communication, inquiry, budgeting and cost analysis, critical thinking skills, etc."* Related to this goal, teachers want to introduce students to actual scientists and the possibility of a career in science.

> *"Teaching science is a way for me to offer information about science careers."*
>
> *"Providing students with an experience working with real data is essential to the success of developing the work force needed for the 21st Century."*
>
> Materials must show a *"link to real-world/ career exploration/ life skills applications."*

Teachers had a wide variety of suggestions about the kinds of curriculum activities that would be desirable, both to engage students and to deliver activities that would be useful to teachers. For example:

> *"Good video clips [live or animated illustrations] that show principles that we cannot show in the field."*
>
> *"Hands on activities, videos and interactive role-playing. Literature is an excellent way to engage them also."*
>
> *"I would want materials to engage students—games, colorful overheads or videos, information on how a degradation of marine environments affects them."*
>
> *"I would like online material to be delivered, as well as print copies for the lab activities."*
>
> *"It is important to be able to easily access specific activities or data."*
>
> *"Align any supplemental materials with the grade level expectations and benchmarks in my state's comprehensive curriculum. Please include this information in your materials."*

"I am more likely to use activities that are offered cafeteria style—select what you need or find useful."

"Things that could be used daily and didn't require a ton of extra materials and set ups (for experiments/ hands-on)."

"Maybe your group could invest in mobile educational trailers."

While these suggestions point in different directions, teachers are clearly concerned about having a variety of engaging materials that are easy to access and use.

While many teachers saw hands-on experiences as essential for deep learning, implementing these activities is not always easy. A few representative comments:

"Students appreciate the 'hands-on' experience, since it fixes the knowledge more deeply into their inquisitive starving minds."

"Students learn more when using hands-on activities and are able to actually see what is happening."

"Hands on kits and equipment are next to impossible to gather."

"Projects that can go home are needed but too expensive for me"

There were mixed feelings about the use of technology.

"Since all of our high school students have laptop computers, anything web or electronically based will be useful."

"It is vital that on-line materials are incorporated into the materials I use because this mimics the way my students get daily information."

By contrast: *"There is far too much on-line already."*

Teachers are also quite concerned about the reliability and usability of technology tools. Even in schools with a lot of technology access, one cautioned, *"We have a very unreliable wireless connection system, therefore, interactive CD's or DVD's including virtual interactive field trips would be quite useful."* Another seemed peeved by encounters with web-quest activities that no longer work. *"I HATE going to a recommended web site only to have it not be there."*

There were a variety of calls for curriculum materials that would integrate topic areas whether it be *"across the sciences"*, or with a particular emphasis on *"science and social studies"* which many see as somewhat neglected given the emphasis on testing reading and math, or integrated with English/ reading or math, or more broadly. *"More music!"* One teacher clearly stated that successful materials *"must show interdisciplinary connections."* These suggestions were not too surprising, especially for elementary and middle school teachers who teach a variety of subject areas.

A number of teachers commented on the importance of curriculum designed to address diverse student needs—a topic we hadn't focused on in the survey. Teachers mentioned a wide variety of differences that they attend to on a regular basis:

"Diversity of our students and their learning styles."

"Modifying curriculum for students with special needs so they can access the curriculum."

"Special education and ESL (English as a Second Language) students"

"1/2 of my class is made up of special ed ...learning disabled and behavior disorders. You would have to consider them in the program."

"My multiage, multi-grade teaching reality."

"Various ability levels. We have students that read at 1st grade level, and at post high school all in the same grade level."

These differences are important to consider in designing curriculum and professional development materials.

A number of teachers were interested in ways to expand access to materials and activities to families and other members of the broader community.

"Availability of materials to other individuals besides teachers is very helpful."

"We had a family night to teach the game and had each family take home their own copy. The game integrated the science, reading and math. I like these things."

"Parents have expressed a need for book-lists, resource lists, and easy/ quick introductions to the lessons"

"Offer reading materials and other extensions from the activities that children and families can do on their own. Inclusion of that piece suggests that this should be common practice and lifelong interest rather than a 'school assignment' or locked within a subject of study."

These sorts of suggestions may also be important to consider in the design of curricular materials.

When commenting on the types of professional development supports they'd need to be successful in implementing new materials, teachers made a wide variety of suggestions. A number stressed the importance of offering college credit *"for certifications,"* with one explaining, *"Many schools will pay for graduate credit courses, but will not pay for 'workshops' even though the cost would actually be lower."* There was a mix of opinions about the importance of offering a stipend for workshop participation, for example:

"I like training in the summer but only with a stipend."

"Some workshops offer a stipend, but I do not especially look for those."

Suggestions for the format and structure of professional development seemed to vary, with some tendency to prefer longer (at least a week), more intensive professional development, often during the summer, but including follow-up during the year.

"I find the year-long or semester-long courses produce more results."

"I would prefer receiving several days training at a time, then follow-up contact later."

"If you could do a two week summer training with a year long project that requires 4 two day follow ups and peer review, then success would occur."

These sorts of more intensive, contextually grounded structures are also the kinds supported by research on the effectiveness of professional development programs.

Teacher suggestions about the content of professional development varied:

"Develop a series of CDs or videos with actual practices and comments from instructors performing the activities to get ideas and experiences."

"Please use the NERRS centers to offer specific teacher trainings [on] how to use material that is created explicitly for the regional SOLs [Standards of Learning]. You have to make each activity specifically address a specific SOL for that state."

"Traveling presentations for schools would be great. Also interactive sister schools."

"On-line professional development is tough to do with such a wonderfully wet topic... more fun outside and not on-line for teachers...especially this OLD ONE!"

Although a teacher in a more remote, rural area said, *"Online resources would be ideal."*

Some teachers had visions of expanding the network of available professional development support by training some to train others.

"If I had more training, I could train the other teachers in more relevant science activities"

"As environmental educators with natural resources agencies…train us, and we'll train others and educate visitors and our communities."

Finally, a few teachers commented on the survey itself. Several complained (reasonably) that it was long, though a few of these thought it might be worth it. *"This survey took a significant amount of my time, I hope it is useful to you!!!!"* Some thought the survey was well designed, saying, *"I think you have covered everything," "I think you hit all the highlights!"* and even, *"You've really designed a well-thought out survey."* Many teachers appreciated that we were interested in and taking seriously their concerns and needs. For example:

"Thanks for your efforts in reaching out to educators."

"Thank you for taking the time to communicate with teachers!"

"Thanks for getting teacher input into this process."

"Gracias por esta encuesta. Ha sido emocionante y diversión."

"Thank you for this survey, it has been exciting and fun."

And a few used the experience of completing the survey as a learning experience for themselves:

"I didn't realize how much material I was not aware of and was not getting."

"A lot of the web sites that you listed I never heard of before, but I am going to check them out."

While these unsolicited, open-ended responses are not necessarily representative, they can be informative to the extent that they fit with other responses on the survey, or with educators other experiences with teachers in schools.

Conclusion

This NERRS needs assessment has gathered information from a wide variety of educators across the US about topics related to estuarine education. The general trends we describe, as well as the contextually based differences, are likely to be of interest to developers, researchers, policy-makers, and others in the field of science education.

In particular, we found that the actual topic of estuaries, to some extent, and scientific concepts that can be taught in the *context* of a study of estuaries to a greater extent, are ones that educators see as important to teach, and already spend some time on. Thus, interesting curricular materials that focus on these concepts and that take a few weeks to

complete would likely be attractive to many teachers and are worth developing. While some educators say that they can only use materials that take just a class period or two, enough are interested in a more coherent set of materials that will take two to three weeks that it's worth developing these types of units and trying to entice those with more limited time to adopt them

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We find that educators are regular users of some kinds of innovative pedagogical techniques such as hands-on and inquiry activities, as well as some that are more traditional such as lecture and demonstration. Other innovative techniques such as analyses of charts, graphs, maps and images, or use of data are less frequently used and would require more curricular or professional development support to be regularly incorporated into classroom practice. Field work and service learning are so infrequently done, or provide such logistical difficulties, that they shouldn't be emphasized in curricular materials, and their use in other programs will require additional support.

Teachers are interested in curriculum materials that focus on interdisciplinary learning opportunities, use authentic contexts that are relevant to local communities, and that support students to understand about human impact on the environment and to develop into responsible citizens who can make a difference about important global issues. However, materials also need to address state or local curriculum requirements and standards, be interesting, at the appropriate level, and do-able with equipment and materials available in classrooms, and teachers need to understand the content itself, if they are to be adopted. Successful curriculum materials and programs will likely need to reflect and address these interests and concerns.

The information gathered and summarized in this NERRS Needs Assessment Report—including variability among teachers in different contexts, at different grade levels, and teaching different subject matter courses—can be useful to designers of curriculum and professional development materials and programs, to researchers and policy-makers trying to understand teachers and their contexts, and to funders interested in how to best promote estuarine education and broader scientific literacy. In particular, we hope that it will serve the NERRS as it moves forward with its K–12 initiatives.